

region, and a gate electrode 9 is formed on the channel region through an insulating layer 8. An interlayer insulating film 11 is formed to cover the gate electrode 9.

#### IN THE CLAIMS

Please amend Claim 5 to read as follows:

5. (Amended) The field-effect semiconductor device according to claim 1, wherein  
said emitter electrode comprises aluminum.

#### REMARKS

Favorable reconsideration of this application, in light of the present amendment and following discussion, is respectfully requested.

Claims 1-10 are pending; and Claim 5 has been amended. No claims have been canceled herewith. It is respectfully submitted that no new matter has been entered by this amendment.

In the outstanding Office Action, Figure 6 was objected to; Claims 1-3 and 5 were rejected under U.S.C. § 103(a) as unpatentable over Sakurai et al. (U.S. Pat. No. 5,962,877, hereafter Sakurai) in view of Sakurai et al. (JP 411284176A, hereafter JP '176) and Okamoto et al. (U.S. Pat. No. 4,903,117, hereafter Okamoto); Claim 4 was rejected under U.S.C. § 103(a) as unpatentable over Sakurai in view of JP '176 and Okamoto, as applied to Claims 1-3 and 5, and further in view of Kim et al. (U.S. Pat. No. 6,229,166, hereafter Kim); Claims 6-8 and 10 were rejected under U.S.C. § 103(a) as unpatentable over Admitted Art (AA) in view of JP '176 and Okamoto; and Claim 9 was rejected under U.S.C. § 103(a) as unpatentable over AA in view of JP '176 and Okamoto as applied to Claims 6-8 and 10, and further in view of Kim.

Applicants thank Examiner Tran for the interview granted Applicants' representative on January 28, 2003. During the interview, independent Claims 1 and 6 were discussed with regard to Sakurai, JP '176, and Okamoto. The Applicants' representative explained that there is no teaching in any of the cited references to support a combination of these references.

Independent Claims 1 and 6 both recite that the barrier metal layer that is formed between the emitter electrode and the interlayer insulating film includes a layer containing nitrogen. As described in the specification at pages 9 and 10, for example, the Applicants discovered that including nitrogen in a barrier metal layer greatly improves threshold voltage characteristics after annealing processing.<sup>1</sup> Based on the Applicants' discoveries, Applicants determined that p-based density may be raised to obtain the same threshold voltage by forming a barrier metal layer containing nitrogen. As a result, the pinch resistance of the p-based region immediately beneath the n<sup>+</sup>-emitter regions may be lowered, so that an IGBT having a greater amount of breakdown withstanding may be provided.<sup>2</sup>

Sakurai relates to an inverter apparatus having an improved switching element. However, as admitted in the Office Action, at page 3, Sakurai does not disclose or suggest a barrier metal layer formed to continuously contact the interlayer insulating film, as recited in the pending claims. Moreover, Sakurai does not disclose or suggest that the barrier metal layer may include nitrogen. In fact, as explained during the interview, there is no teaching or suggestion anywhere in Sakurai that including nitrogen would provide any benefits, such as improving voltage characteristics. Additionally, Sakurai does not disclose or suggest that an emitter is formed of aluminum.

JP '176 provides pure aluminum at an emitter electrode while a barrier layer is provided between the emitter electrode and a MOS gate. JP '176 indicates that a barrier layer

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<sup>1</sup> Specification, page 10, lines 1-4.

<sup>2</sup> Specification, page 10, lines 12-18.

is useful for an emitter composed of pure aluminum. As the barrier metal layer of JP '176 is specifically noted for its use with pure aluminum in the structure of JP '176, it is respectfully submitted that one of ordinary skill in the art would not have been motivated to combine the non-aluminum structure of Sakurai with the barrier metal layer of the differing structure of JP '176. Furthermore, the Office Action fails to point to any teachings within either of these references to support this proposed combination. Consequently, Applicants respectfully submit that the proposed combination is based solely upon improper hindsight, and respectfully requests that this rejection be withdrawn.

Okamoto relates to insulating films that have contact holes selectively formed within the films. The film configuration of Okamoto is described as able to prevent the precipitation of silicon into the contact hole.<sup>3</sup> However, Okamoto does not disclose or suggest that the withstanding voltage may be improved in an IGBT, as discovered by the Applicants.

Okamoto merely suggests that titanium nitride and tantalum nitride may be useful to avoid alloys spike phenomena in the junction between the barrier layer and the silicon substrate.<sup>4</sup>

Okamoto certainly does not suggest that a barrier layer containing nitrogen would be beneficial in a structure having an aluminum emitter. Accordingly, it is respectfully submitted that the proposed combination of Sakurai, JP '176, and Okamoto is based solely upon hindsight reconstruction. Specifically, Okamoto does not disclose or suggest the use of any type of emitter, regardless of the emitter composition. In fact, although the second metal layer 6 of Okamoto is described as containing aluminum, Okamoto only describes that boron is prevented from diffusing and silicon is prevented from precipitating.<sup>5</sup>

Applicants therefore respectfully submit that no motivation exists within the teachings of any of Sakurai, JP '176, or Okamoto to suggest the proposed combination. It is therefore

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<sup>3</sup> Okamoto, Abstract.

<sup>4</sup> Okamoto, col. 3, lines 7-12.

respectfully submitted that the combination of these three references is based solely upon improper hindsight.

With regard to the rejection of Claim 4 as unpatentable over Sakurai in view of JP '176 and Okamoto, and further in view of Kim, this rejection is traversed. Claim 4 depends from independent Claim 1, and is also allowable.

As noted above, Sakurai, JP '176, and Okamoto all fail to provide a motivation to support the combination of these references.

It is respectfully submitted that Kim fails to remedy the defects above-noted with regard to Sakurai, JP '176, and Okamoto. Kim relates to a ferroelectric random access memory device and fabrication method. Kim describes providing an upper and lower seed layer that is crystallized prior to the ferroelectric layer during thermal treatment.<sup>6</sup> However, Kim does not disclose or suggest the use of any type of emitter, and certainly fails to disclose that an emitter may be formed of aluminum. Kim further does not disclose or suggest the use of any type of barrier layer. In light of these deficiencies, Applicants respectfully submit that the combination of Kim with Sakurai, JP '176, and Okamoto is based solely upon hindsight reconstruction. Quite simply, there is a lack of motivation in any of these references to support the proposed modification.

With regard to the rejection of Claims 6-8 and 10 under 35 U.S.C. § 103(a) as unpatentable over AA in view of Sakurai and Okamoto, this rejection is respectfully traversed. As noted above, Claim 6, from which Claims 7, 8, and 10 depend, recites that a barrier metal layer is formed between the emitter electrode and the interlayer insulating film and includes a layer containing nitrogen.

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<sup>5</sup> Okamoto, col. 3, lines 17-23.

<sup>6</sup> Kim, Abstract.

As earlier noted, there is no support in the teachings of either JP '176 or Okamoto to support the combination of these references. It is respectfully submitted that the AA fails to remedy the deficiencies above-noted with respect to JP '176 and Okamoto.

Specifically, it is only in light of the Applicants' written description in the present specification that the proposed combination may be derived. For example, it is only in light of the Applicants' description in the Background of the Invention section at pages 1-3, for example, that the deficiencies of the prior art are realized. It is only through the Applicants' inventive efforts and present written description that the claimed invention may be achieved.

Therefor, because there is no support in the teachings of the AA, JP '176, or Okamoto to support the combination of these references, it is respectfully requested that this rejection be withdrawn.

Regarding the rejection of Claim 9 under 35 U.S.C. § 103(a) as unpatentable over AA in view of JP '176 and Okamoto, as applied to Claims 6-8 and 10, and further in view of Kim, this rejection is traversed. Claim 9 depends from Claim 6.

As noted above, there is no support in the teachings of any of AA, JP '176, or Okamoto to support the proposed combination. Additionally, it is respectfully submitted that Kim fails to remedy this deficiency.

As noted above, Kim does not disclose or suggest the use of any type of emitter. Therefore, Kim necessarily fails to disclose or suggest that an emitter may be formed of aluminum. Kim further does not disclose or suggest the use of a barrier layer. Consequently, in light of these deficiencies, it is respectfully submitted that the proposed combination is based solely upon hindsight. It is therefore respectfully requested that this rejection be withdrawn.

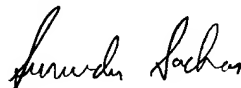
With regard to the objection to Figure 6, Figure 6 has been amended under separate cover to recite the legend "Background Art". This amendment is supported by the

Applicants' description in the Background of the Invention section, at page 1 of the specification, for example. It is therefore respectfully submitted that no new matter is added by this amendment.

Consequently, in view of the foregoing discussion and present amendment, it is respectfully submitted that the pending application is in condition for immediate allowance. An early and favorable action is therefore respectfully requested.

Respectfully submitted,

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IN THE SPECIFICATION

Page 7, lines 2-17, please amend the paragraph to read as follows:

--Fig. 1 is a vertical cross-sectional view that schematically shows the structure of an insulated gate bipolar transistor (abbreviated as IGBT hereafter) in accordance with a first embodiment of the present invention. In this IGBT 10, an  $n^+$ -buffer layer 3 and an  $n$ - layer 2 are successively formed on a  $p^+$ -collector layer 4 that consists of a  $p^+$ -semiconductor substrate. Also, a  $p$ -base region 6 is formed as part of the upper surface of the  $n$ - layer 2. Further, high-density impurities of  $n$  type are selectively diffused to form  $n^+$ -emitter regions 7 as part of the upper surface of the  $p$ -base region 6. The part of the surface region of the  $p$ -base region 6 which is located between the  $n$ - layer 2 and the  $n^+$ -emitter regions 7 forms a channel region, and a gate electrode 9 is formed on the channel region through an insulating layer 8. [And an] An interlayer insulating film 11 is formed to cover the gate electrode 9.--

IN THE CLAIMS

Please amend Claim 5 as shown below:

5. (Amended) The field-effect semiconductor device [accroding] according to claim 1, wherein said emitter electrode comprises aluminum.